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Health Risk Assessment of Drinking Water Sources Available to Offa Communityand Environs

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ABSTRACT
Good quality water is essential for the sustenance of life. Monitoring of water quality is of utmost importance in order to prevent outbreak of diseases associated with low quality water. Therefore, the study was aimed at assessing the health risk associated with drinking water sources in selected villages in Offa and Oyun Local government areas, Kwara State. The selected indicator organisms were determined using most probable number techniques and the Portable Microbiology Laboratory kit technique (colilert and petrifilm). Biochemical characterization was carried out on the isolates using API kit while antibiotic susceptibility test was carried out using Kirby-Bauer method. Molecular characterization of the multiple drug resistant strains of Escherichia coli was performed using polymerase chain reaction based 16SrRNA sequence. The physicochemical parameters (pH, Turbidity, Total dissolved solids, Electric conductivity) were investigated using HACH 2000 meter while Magnesium, Fluoride and Calcium ions were determined using Ethylenediaminetetraaceticacid (EDTA) titration method. The location of each sampling site was determined using global positioning system (GPS). Total coliform MPN values ranged from 2 to 17 MPN/100ml, feacal coliform 0.0 to 14 MPN/100ml. The results obtained for viable count of drinking water collected from motorized borehole, hand pump borehole, well and pond ranged from 1.5 x 10^1 to 4.1 x 10^2 cfu/ ml (Staphylococcal count) with the highest and lowest values recorded in Ilota pond and Gbosun motorized borehole respectively, 0.3 x 10^1 to 4.7 x 10^1 cfu/ ml (Pseudomonas count) with the highest and lowest values recorded in Ilota pond and Gbosun motorized borehole and 0.9 x 10^1 to 2.8 x 10^1 cfu/ ml (Bacillus count) with the highest and lowest values recorded in Gbosun well. The result obtained from the colilert and petrifilm plates confirmed the presence of the coliforms and feacal coliform (E.coli) in some of the samples collected. Ilota pond poses the highest health risk with 15 colonies of E. coli isolated with petrifilm plate. This was followed by Temidire well 1 with 14 colonies of E. coli. Other sources of water with potential health risk are: Kere-aje well 1 with 13 colonies of E. coli, Kere-aje well 2 and Ogbondoroko well 4 each with 8 colonies of E. coli, Ilota well 1 and Ogbondoroko well 1 each with 6 colonies of E. coli, Ilota well 2 and Ogbondoroko well 3 each with 5 colonies of E. coli, Alenibare well 1 and Ogbondoroko well 5 each with 3 colonies of E. coli while Bolohunduro well and Temidire well 2 pose the health risk with 2 colonies of E. coli each. The phylogenetic tree revealed JCM1649 and UIWRF0947 strains of E. coli were observed to be multiple drug resistant. The pH values of all the water sampled ranged from 5.9 to 7.2 with the least and highest values obtained from Ilota pond and Kere-aje well 2, respectively. The highest turbidity value of 3.9 NTU was recorded in the water sample collected from Ilota pond while Gbosun and Kere-aje motorized borehole had the lowest turbidity value of 2.0 NTU. Total dissolved solids (Mg/L), Electric conductivity (µS/cm), Calcium ion (Ca^{2+}), Fluoride ion (F^-) and Magnesium ion (Mg^{2+}) of all the water sampled ranged from 51 to 81,130 to 171, 7.5 to 12.5, 0.32 to 0.43 and 3.7 to 7.9, respectively. The results obtained from this study revealed the potential health

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risk of some of the water sources in the study villages which require prompt interventions.
Keyword: Colilert medium, Petrifilm plate, E. coli and water sources.

I. INTRODUCTION

The availability of portable water for drinking in every community around the globe is very essential for the sustenance of life. Good water sources should be adequately provided for the well being of the populace.

Portable water sources are essential not only for drinking purposes, but also for domestic uses such as washing, bathing and even for irrigation practice.

According to Omalu, Eze and Olayemi (2010), majority of the regions in Nigeria and other developing countries are experiencing shortage of good quality water supply as the portable water are mostly available in the urban areas.

Approximately, one-third of the world's populations use ground or well water which can easily be prone to varieties of contamination as a result of the several anthropogenic activities taking place around the water sources where about 35-37 million people are facing adverse health-related consequences.

Homoida and Goja (2013) reported that contaminated drinking water poses a high risk of human's health as it may contain pathogenic microorganisms and the lack of access to adequate portable water supplies result to the occurrence of water-borne diseases.

Water is the most important natural resources and there are many conflicting demands for it. As the world remains today, no single day passes without water been put to use by every individual. Water remain the most important and indispensable commodity that supports the existence of life.

The widespread problem of water pollution is jeopardizing our health because unsafe water kills more people each year than war and all other forms of violence combined as reported by Natural Resources Defense Council (NRDC, 2022).

Water being a universal solvent is uniquely vulnerable to pollution as it is able to dissolve more substances than any other liquid on earth (NRDC, 2022).

Onyango,Okoth,Kunyang and Aliwa (2018) reported that Good quality water is essential for the sustenance of life and monitoring its quality is of utmost importance in order to prevent any disease outbreak associated with low quality of water. Good quality water supply and accessibility are one of the objectives of the sustainable development goals (SDGs) and aims at ensuring environmental sustainability.

The sources of water like streams, lakes, rivers as well as unprotected open wells are vehicles for water borne bacterial diseases such as cholera and typhoid fevers. Untreated waters can equally transmit water washed viral enteric disease like hepatitis caused by hepatitis A and E viruses, gastroenteritis caused by rotaviruses, noroviruses and sapoviruses. Other enteric viruses that cause ill-defined diseases are adenoviruses, astroviruses, coxsackieviruses and echoviruses (Burgess and Pletschke, 2012).

The lack of access to adequate portable water supplies results to the occurrence of diseases. Contaminated drinking water poses a high risk to human health as it may contains pathogens (Homaida and Goja, 2013). Water pollutants can be categorized into contaminants of biological origin, physical origin and chemical origin according to their properties (Fuquan, Guodong, Huazhun, Shangchuan and Xiuyuan,2009).

One of the serious problems faced by the populace in developing countries is the contamination of water bodies with feacal materials, industrial sewage, domestic and agricultural wastes (Homaida and Goja, 2013).

Population increase has exerted more pressure on the water availability. Consequently, more than 1.2 billion people worldwide do not have access to safe water (Onyango et al., 2018). Majority of the rural dwellers in developing countries lack access to portable water. Seventeen (17) % of children under the age of 5 die annually as a result of diarrhea usually following the intake of contaminated water (Roch, Gratien, Hermione, Yves, Gabriel, Didier, Ghislain and Michel, 2016). Majorly, people residing in some villages within Offa and Oyun local

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government areas of Kwara State lack assess to portable water supply which negatively affected their wellbeing. People of these communities resulted to drinking of water majorly from unprotected water sources such as well and pond.

The rural water sources and water quality health risk assessment show relationship between water quality and human health. The health risk assessment can provide scientific information for the management and protection of rural water sources (Fuquan et al., 2009). The geographic information system (GIS) in health risk assessment can be adopted to establish relationship between the water-borne pathogens and the associated environmental factors thereby providing explanation for possible causes of water borne diseases and the implications on the community (Olalubi, Ajao, Sawyerr, and Salako, 2018).

RESEARCH OBJECTIVES

The objectives of this study are to:

i. identify the major sources of water available to the communities and the proportion of the community that have access to improved water sources;

ii. determine the quality of the communities' water sources and assess the potential health risk associated with the water sources and

iii. recommend interventions that may be necessary to ensure sustainable access to safe drinking water.

II. MATERIALS AND METHODS

Surveillance visit was undertaken to identify community schools without good quality drinking water sources within Offa and Oyun Local Government Areass of Kwara State. The selected study areas were Alenibare, Bolohunduro, Gbosun, Igbonna G, Ilota, Kanmonu, Kere-aje, Ogbondoroko, Reke-oja and Temidire. All the sources of water (motorized borehole, hand pump borehole, well, and pond) available to and used by each community school were identified and defined as recommended by the World Health Organization (WHO, 2004; 2011).

Plate 1 A: Temidire well

Plate 1 B: Kere-aje well 2

Plate 1 C: Kere-aje motorized borehole

Plate 1 D: Kanmonu hand pump borehole

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Plate 1 E: Alenibare hand pump borehole

1 ..lota pond

Plate 1A-F: Selected sampling sites and surrounding anthropogenic activities

A three part questionnaire was designed based on the WHO guideline for drinking water quality. The first part was focused on demographic information, the second part looked at water sourcing and the third part was based on water usage. The close ended questionnaire was administered to thirty three (33) residents community schools teachers of the ten (10) different communities where twenty five (25) samples of drinking water were collected in a completely randomized manner. However, household whole schools were targeted rather than individuals. The questionnaire was directly administered and collected immediately.

Samples of water from the various sources for drinking and other uses were collected between October 2018 and January 2019 with sterile transparent whirl pack sample bag of 200 ml by volume. The samples were coded (sample ID) first based on the selected alphabets from the name of each village school as ALB, BOH, GB, IGB G, ILO, KAN, KA, OGBO, RO and TE representing Alenibare, Bolohunduro, Gbosun, Igbonna G, Ilota, Kanmonu, Kere-aje, Ogbondoroko, Reke-oja and Temidire respectively (Fig.1). The second part of coding was based on the type of water source as MBH, HPB, W and P representing motorized borehole, hand pump borehole, well and pond, respectively. The last part of the sample code consisted 1,2,3,4 and 5 represented the different sample site of the same water type within the same village. A total of twenty-five (25) samples of drinking water from different sources within the study areas were purposively collected aseptically for analysis. The samples consisted of sixteen (16) well water, five (5) hand pump borehole water, three (3) motorized borehole water and one(1) pond water.

The samples were transported immediately to the microbiology laboratory of the Science Laboratory Technology Department, Federal Polytechnic, Offa where they were examined

Scale: 1:1,000,000

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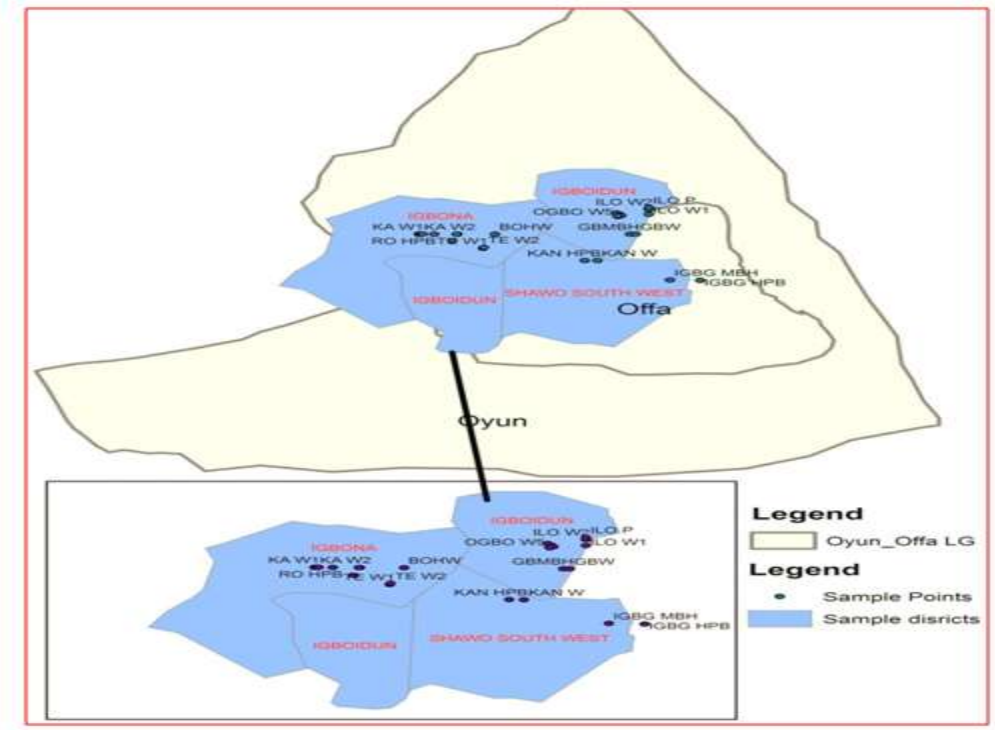

Fig. 1: The Sampling Sites (points) and location of wards within the local governments

Analytical Methods

The quality of water for each water source was analyzed based on WHO guideline for drinking water (WHO, 2011).

The population of heterotrophic bacteria in each water sample was determined by inoculating 1ml of the sample on plate count agar. Mannitol salt agar was used for the enumeration of Staphylococcus aureus, Centrimide agar was used for the enumeration of Pseudomonas spp while Tryptic soy agar and KF streptococcal agar were used for the enumeration of Bacillus Spp and feacal Streptococci respectively. All these media were prepared based on the manufacturers description. Each inoculated medium was incubated at 37 ^{o}C for 24-48 hours. The bacterial counts were expressed as colony forming units per ml (cfu/ml) as described by (Onyango et al., 2018). The isolates from all the media were sub-cultured separately on sterile nutrient agar plates. The plates were incubated at 37 ^{o}C for 24 hours in order to carry out morphological and biochemical tests.

The total coliform bacteria and feacal coliform bacteria were determined as most probable number (MPN) using the multiple tube fermentation test as described by Folorunso, Adetunji, Laseinde, and Onibi, (2014). The multiple tube fermentation test was performed in three steps using lactose broth medium. The steps include: (1) Presumptive test (2) Confirmatory test and (3) Completed test.

The lactose broth was weighed and dispensed in distilled water based on the manufacturer description to prepare both double and single strength media. 10ml of the double strength broth was dispensed separately in five tubes and the single strength broth in 10 tubes. The inner vial (Durham's tube) was inserted in each of the fifteen tubes in inverted position and they were examined to be full of the medium with no air bubble. All the fifteen tubes were sterilized inside the autoclave at 121 ^{o}C for 15 minutes.

Presumptive test: After sterilization of the medium, the tubes and content were allowed to cool down and inoculated with water sample. 10ml each of water sample was inoculated in the five tubes containing 10ml double strength broth using sterile pipette. One ml each of water sample was added to 5 out of 10 tubes containing single strength broth while 0.1ml each of water sample was inoculated into the remaining 5 tubes. All the tubes were incubated at 37 ^{o}C for 24 hours. The number of positive tubes (the tubes that showed both acid production as a result of

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colour change in the medium and gas production as trapped with inverted Durham's tubes) were counted and recorded as MPN/100ml of the sample. This procedure of presumptive test was repeated to enumerate the feacal coliform (thermotolerant) bacteria of each water sample by incubating the tubes at elevated temperature of 44.5 ^{o}C for 24 hours. The results were then recorded as MPN/100ml of the sample.

Confirmatory Test: Sterilized wire loop was used to transfer 2 drops of feacal coliform culture medium from each of the fermentative tubes with presumptive positive result to:

1. Three (3) ml of lactose broth inside the fermentative tube containing inverted Durham's tubes.
2. Nutrient agar slant.
3. Three (3) ml of tryptone water. The inoculated lactose broth fermentation tube and the tryptone water were incubated at 44.5 ^{o}C for 24hiurs while the inoculated agar slant was incubated at 37 ^{o}C for 24 hours. Gram stained preparation was made from the slant and viewed under the microscope to reveal Gram-negative non-spore forming rods. Kovacs reagent (0.1 ml) was added to the tryptone water after incubation and was gently mixed. The presence of indole was indicated by a red colour forming a film over the aqueous phase of the medium.

Completed test: The inoculum from each positive tube of the confirmatory test was streaked on plates of Eosin methylene blue (EMB) agar which had previously prepared according to the manufacturer description. The plates were incubated at 44.5 ^{o}C for 24 hours.

Potential health risk was equally assessed by inoculating 10 ml of each water sample into the tube of colilert specialized medium containing O-nitrophenyl-β-D-galactopyranoside (ONPG) and 4-methylumbelliferyl-β-D-glucuronide (MUG) as the only nutrient. Also, 1ml of each water sample was inoculated into the 3M petrifilm aqua coliform plate. The colilert tubes and petrifilms were incubated at temperature of 37^{o}C for 24 hours. After the incubation period, the colilert tubes with positive coliforms growth that is, yellow colouration of the medium were observed under long wave length ultra violet (UV) light for fluorescence to detect the presence of Escherichia coli.

The isolates of E. coli obtained in water sample collected from Temidire well 1 were subjected to antibiotic susceptibility testing using Kirby-Bauer method as described by Odonkor and Addo (2018).

The isolates from this water source was used because it has the highest number of E. coli isolates out of all the well water samples analysed. Also, Temidire community school has no other sources of water apart from well.

The isolates were inoculated into plates of nutrient agar incubated for 24 hours at 37^{0}C after which each isolates was suspended in sterile normal saline (0.9% w/v Nacl) using a sterile wire loop until the turbidity was equivalent to 0.5 Mcfarland standard. Each standardized inoculum was separately streaked on the entire surface of Mueller-Hinton agar plates using sterile cotton swab Penicillin, Gentamicin, Erythromycin, Chloramphenicol, Ampicillin, Tetracycline antibiotic disks were aseptically placed using sterile forceps and all the plates were incubated at 37^{0}C for 24 hours.

All isolates obtained were characterized based on colonial morphology, staining reaction and biochemical characteristics. The colonial morphology of the organisms were observed to reveal the shape, size, consistency, optical characteristics, pigmentation and elevation. The microscopic examination and staining techniques were carried out to determine the cellular morphology of the isolates.

Various biochemical tests were carried out on the bacterial isolates. These tests included catalase, oxidase, coagulase, urease, Indole, starch hydrolysis, methyl red, voges proskaur, spore and citrate.

The E. coli isolates with multiple drug resistance strains were further characterized using molecular method of polymerase chain reaction (PCR) based on 16SrRNA sequence.

This was done for confirmation of bacteria isolated from the water sample and to ascertain the strains of bacteria. The first step involved DNA extraction from the isolates already in broths, second step was based on Polymerase Chain reaction and the third step of molecular characterization was on sequencing to get the nucleotides of the organism.

The physicochemical parameters were determined according to the procedure of Homaida and Goja (2013). The turbidity of each water sample was determined by Nephlometric method using (HACH 2000) turbidity meter and the results were

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reported in Nephlometric Turbidity Unit (NTU). The total dissolved solids (TDS) of each water sample was determined with (HACH 2000) TDS meter. The electric conductivity (EC) in µs/cm of each water sample was observed at 25^{o}C using conductivity meter (HACH 2000). Magnesium, fluoride and calcium were determined using titration method. All these instrument were calibrated and subsequently dipped separately into each of the water sample. All the readings were taken and recorded.

III. RESULTS

The results of the Heterotrophic plate counts (HPC), Total coliform count (TCC), Feacal coliform counts (FCC) and Feacal Streptococcal counts (FSC) are shown on Table 1. The Staphylococcal counts were ranged from 7.2 x 10^1 - 3.8 x 10^2cfu/ml for well water, 3.5 x10^1 - 6.3 x10^1 cfu/ml for hand pump borehole while the range for the motorized borehole was 1.5 x 10^1 - 3.1 x 10^1. For the pond water sample, Staphylococcal counts was 4.1 x 10^2 cfu/ml. The growth counts for Pseudomonas were ranged from 0.8 x 10^1- 3.9 x 10^1 and 0.5 x 10^1- 0.8 x 10^1 for well water and hand pump borehole water samples respectively. Out of the three motorized borehole water sampled, only the water sample from Gbosun motorized borehole had growth count for Pseudomonas whichwas 0.3 x 10^1cfu/ml while the pond had 4.7 x 10^1cfu/ml.

The growth counts for Bacillus were ranged from 0.9x10^1-2.1x10^1 for well water while the pond had 2.8x10^1. Both the hand pump borehole and motorized borehole had no growth for Baci)llus. The pond had the highest count while the least growth was observed from well water sample from Gbosun motorized borehole. Six (6) well water samples collected from Bolohunduro well, Ilotal well 2, Kere-aje well 1 and 2, Ogbondoroko well 3 and Temidire well 1 had Bacilli growth in all 28% of the water sampled had Bacillus spp.

Total coliform MPN values were ranged from 4.0 to 14/100ml, 2.0 to 6.0/100ml for well and hand pump borehole water respectively. Nonof the motorized borehole water sampled has coliform growth. The pond water had the highest total coliform MPN value of 21/100ml.

For the feacal coliform MPN values, the pond water sample had the highest MPN value of 17/100ml while the lowest MPN value of 2/100ml detected in hand pump well water sample from Alenibare community. The well water samples had MPN values ranged from 2.0 to 12/100ml with the highest value recorded from Temidire well 1. Non of the motorized borehole and hand pump borehole water samples had feacal coliform growth. The feacal streptococcal growth counts were ranged from 7.0 to 32 cfu/ml for the well water samples with the highest and lowest counts observed from Kere-aje well 1 and Ilota well 1 respectively. The hand pump borehole water sample collected from Alenibare village had 8 cfu/ml count of feacal Streptococciwhile 5 cfu/ml was counted in Reke-Oja hand pumped borehole water samples. Out of the five borehole water samples collected, Gbosun, Bolohunduro and Igbonna Garage water samples had no feacal Streptococci. The highest feacal streptococcal counts from all the water samples was recorded in the sample collected from Ilota pond with 43cfu/ml.

Table 1: The Bacteriological Examination of Drinking Water Samples from Various Sources

Sample	Staphylococcal count	Pseudomonas count	Bacillus Count	TCC MPN/100ML	FCC MPN/100ML	FSC Count
Well	7.2x10^1 – 3.8x10^2	0.8x10^1 – 3.9x10^1	0.9x10^1 – 2.1x10^1	4.0-14	2.0-12	0.7x10^1- 3.2x10^1
Hand Pump Borehole	3.5x10^1 – 6.3x10^1	0.5x10^1 – 0.8x10^1	0.0	2.0 - 6.0	0.0-2.0	0.5x10^1 – 0.8x10^1
Motorised Borehole	1.5x10^1 – 3.1x10^1	0.3x10^1	0.0	2.0 - 4.0	0.0	0.0
Pond	4.1x10^2	4.7x10^1	2.8x10^1	17	14	4.3X10^1

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TCC = Total coliform count; FCC; Feacal coliform count; FSC = Feacal streptococci count;

The Portable Microbiology Laboratory kit (Colilert and Petrifilm) water analysis results are shown on Table 2 which revealed that all the water samples collected except the three motorized borehole water samples showed positive result inside the colilert tubes after incubation period by changed in colour of the medium to yellow as a result of the hydrolysis of O-nitrophenyl -β-D-galactopyranoside (ONPG) which released O-nitrophenol.

The results of the 4-methylumbelliferyl-β-D-glucuronide (MUG) modification inside the colilert tube to yield fluorescence upon observing under the UV light which indicated the presence of Escherichia coli corroborate with the 3M Petrifilm aqua plate positive counts for Escherichia coli, that is, bluish colonies with gas. In all, thirteen (13) water samples, all well water had E. coli bluish colony growth with gas on the petrifilm plates representing 52%.

The predicted distribution map for the E. coli counts on the petrifilm is shown in figure 2. The result indicated that the presence rate of E. coli in Ilota pond, Temidire well 1, Kere-aje well 1 and 2 and Ogbondoroko well 1, well 2 and well 4 is high which puts these communities at very high risk level of water borne diseases with the presence of dump site, soak away as major risk factors at very close distance of less than 10 metres to the sampling sites.

However, sampling sites with very low risk level of water borne diseases included all the motorized borehole and hand pump borehole. Table 2 shows the comprehensive results for various water samples analysed using colilert and petrifilm with the corresponding risk level of water borne diseases.

Morphological and Biochemical identification test of the bacteria isolated revealed the presence of Bacillus, Pseudomones, Staphlococus, Streptococcus and Escherichia coli as shown on table 3.

The antibiotics susceptibility testing of the Escherichia coli isolated from Temidire well 1. The zones of inhibition of each E. coli isolate was measured in millimeter and recorded as shown in Table 4. Two out of the eleven isolates were observed to be multidrug resistant by showing resistivity to four antibiotics.

The nucleotide sequence analysis of the test isolates using clustal W program revealed that isolate KB1 showed maximum homology (99%) with Escherichia coli strain (JCM1649). Also, Isolate KB 2 was found to show maximum (96%) homolog with Escherichia coli sp (UIWRF0947). The test bacterial isolates clustered with members of the genus Escherichia thus differentiating bacterial isolates on the genetic basis shown in Figure 6.

Table 2: Water Samples Analysis using Colilert and Petrifilms

S/N	Sample ID	Date collected	Location Collected	24hr Colilert		24hr Petrifilm # Blue &Gas	Risk Level
				ONPG	MUG		
1.	ALB HPB	14-01-19	Alenibare Hand pumped borehole	+	-	0	Low
2.	ALB W1	14-01-19	Alenibare Well 1	+	+	3	High
3.	ALB W2	14-01-19	Alenibare Well 2	+	-	0	Low
4.	BOH HPB	14-01-19	Bolohunduro Hand pumped borehole	+	-	0	Low
5.	BOH W	14-01-19	Bolohunduro Well	+	+	2	High
6.	GB MBH	14-01-19	Gbosun Motorized BH	-	-	0	Nil
7.	GB W	14-01-19	Gbosun Well	+	-	0	Low
8.	ILO W1	04-02-19	Ilota well 1	+	+	6	High
9.	ILO W2	14-01-19	Ilota well 2	+	+	5	High
10.	ILO P	04-02-19	Ilota pond	+	+	15	Very High

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11.	Igb G HPB	04-03-19	Igbonna garage hand pumped borehole	+	-	0	Low
12.	Igb G MBH	04-03-19	Igbonna garage motorized borehole	-	-	0	Nil
13.	KA W1	04-02-19	Kere-aje Well 1	+	+	13	Very High
14.	KA W2	04-02-19	Kere-aje Well 2	+	+	8	High
15.	KA MBH	04-02-19	Kere-aje motorized borehole	-	-	0	Nil
16.	Kan HPB	04-02-19	Kanmonu Hand pumped borehole	+	-	0	Low
17.	Kan W	04-02-19	Kanmonu Well	+	-	0	Low
18.	Ogbo W1	04-03-19	Ogbondoroko Well 1	+	+	6	High
19.	Ogbo W2	04-03-19	Ogbondoroko Well 2	+	-	0	Low
20.	Ogbo W3	04-03-19	Ogbondoroko Well 3	+	+	5	High
21.	Ogbo W4	04-03-19	Ogbondoroko Well 4	+	+	8	High
22.	Ogbo W5	04-03-19	Ogbondoroko Well 5	+	+	3	High
23.	R.O HPB	04-02-19	Reke-Oja hand pumped borehole	+	-	0	Low
24.	TE W1	04-03-19	Temidire Well 1	+	+	14	Very High
25.	TE W2	04-03-19	Temidire Well 2	+	+	2	Low

Risk Level	E. coli in sample	Colliert MUG+	# Blue Colonies on Petrifilm
Nil	-	-	0
Low	<1/10 ml	-	0
Moderate	1-10/10 ml	+	0
High	1-10/ml	+	1-10
Very High	>10/ml	+	>10

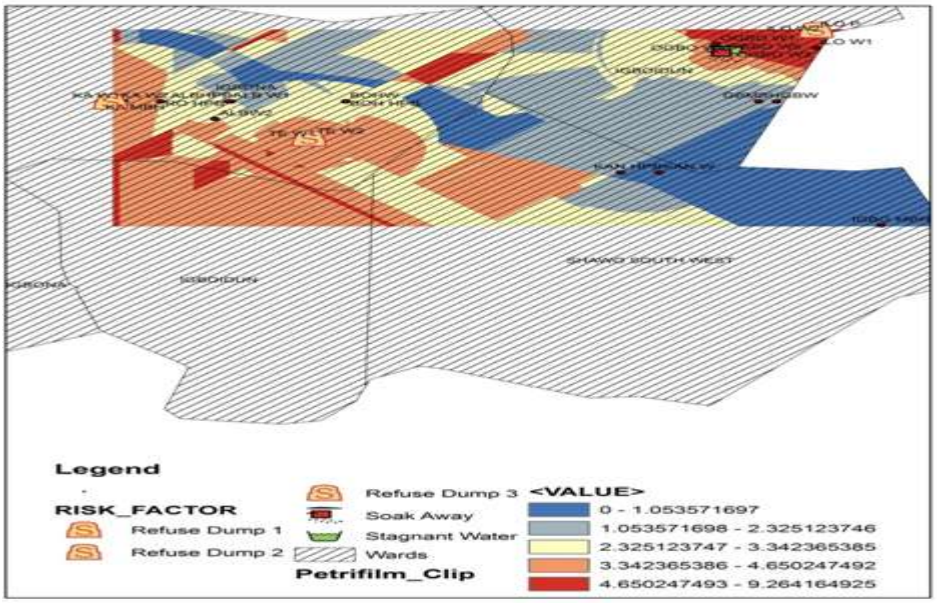

Fig. 2: Map for the E. coli Growthon Petrifilm

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Table 3: Morphological and Biochemical Characteristics of the Isolates

Tentative organisms	Elevation	Surface	Cons	Pig	Gram staining	Shape	Spore staining	Motility	Catalase	Oxidase	Glucose	Indole	Coag	MR	VP	Cit	Ure
E. coli	Raised	Smooth	Mucoid	Greyish white	- ve	Short rod	- ve	+ ve	+ve	-ve	+ve	+ve	-ve	+ ve	-ve	-ve	-ve
Bacillus	Flat	Rough	Mucoid	Yellow	+ ve	Rod	+ ve	+ ve	+ve	-ve	+ve	-ve	+ve	- ve	+ve	+ve	- ve
Staphlococcus	Convex	Smooth	Soft	Golden yellow	+ ve	Sphere (cluster)	- ve	- ve	+ve	-ve	+ve	-ve	+ve	+ve	+ve	-ve	-ve
Pseudomonas	Flat	Rough	Mucoid	Blue green	- ve	Rod	- ve	+ ve	+ve	+ve	-ve	-ve	-ve	-ve	-ve	+ve	-ve
FeacalStreptococcus	Raised	Rough	Mucoid	Dark red	+ ve	Sphere (chain form)	- ve	- ve	-ve	-ve	+ve	-ve	+ve	+ve	+ve	-ve	+ve

Key: MR: Methyl red, VP: Voger proskauer, Cit.: Citrate, Ure: Urease, Pig: Pigmentation, Cons: Consistency, Coag.: Coagulase - ve = Negative, + ve = Positive

Table 4: Antibiotic susceptibility test on E. coli isolates from Temidire well 1

Isolates	Pen. (clear zone) in mm	Eryth. (clear zone) in mm	Tetra (clear zone) in mm	Gent (clear zone) in mm	Amp. (clear zone) in mm	Chlor. (clear zone) in mm
Is1	21 ±1.00	23 ±0.87	–	23±0.71	–	28 ±1.00
Is2	30 ±1.32	23 ±1.00	–	22 ±0.00	30 ±0.00	–
Is3	–	–	–	32 ±1.00	33 ±1.00	–
Is4	25 ±1.00	27 ±1.32	25 ±0.00	–	–	30 ±1.00
Is5	–	28 ±1.00	32±0.71	31 ±1.32	–	32 ±0.87
Is6	–	32 ±0.00	25 ±0.71	25 ±1.00	28 ±0.00	–
Is7	–	–	–	23 ±0.87	–	29 ±1.00
Is8	28 ±1.32	+	33 ±0.87	–	25 ±0.87	–
Is9	29 ±0.00	–	–	35 ±1.00	31 ±0.71	28 ±0.00
Is10	30 ±1.00	32 ±1.00	28 ±0.00	–	26 ±1.00	–
Is11	–	–	28 ±0.87	32 ±0.71	33 ±0.00	–

Key: Pen = Penicillin, Eryth = Erythromycin, Tetra = Tetracycline, Gent = Gentamycin, Amp = Ampicillin, Chlor = Chloramphenicel
Is1 – Is11 are isolates
– : No zone observed

The results for the physicochemical parameters of the various water sources are shown in table 5. The pH values of all the water sampled from different villages ranged from 5.9 – 7.2. Out of the 25 sampled water, Temidire well1 and 2, Ilota well 1 and 2, Ogbondoroko well 4, Reke-Oja hand pump borehole, Kere-Aje motorized borehole, Kere-Aje well 2, Kanmonu well, Gbosun motorized borehole and Alenibare hand pump borehole water sample had pH values that conform with WHO standard pH value of (6.5-8.5). The predicted distribution map for pH values in figure 3 revealed that: Alenibare well 1 and well 2, Bolohunduro well and hand pump borehole, Kanmonnu hand pump borehole, Kere-aje well 1, Reke-oja hand pump borehole, Ilota pond, Igbonna garage motorized borehole, Igbonna garage hand pump borehole, Ogbondoroko well 1, 2, 3 and 5 and Gbosun well had pH values that are slightly acidic indicated by the blue colour on the map. The highest pH value of 7.1 was recorded in Kere-aje well 2 and Temidire well 1 while the lowest value of 5.9 was recorded in Ilota pond.

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Determination of the turbidity of all the water samples showed that WHO standard of any water sample should be less than 5 NTU as reported by Homaida and Goja (2013). Ilota pond had the highest turbidity value of 3.9 NTU while the lowest turbidity value of 2. 0 NTU was observed in Gbosun and Kere- Aje motorized borehole water samples. The predicted distribution map for turbidity values in figure 4 shows that Bolohunduro hand pump borehole, Ilota pond, Reke-oja hand pump borehole, Gbosun well 2 had higher turbidity values while lower values recorded in Gbosun hand pump borehole, Temidire well 1 and 2, Igbonna garage motorized and hand pump borehole.

The total dissolved solids (TDS) mg/l, Electric conductivity (EC) µs/cm, calcium ion (Ca^{2+}), fluoride ion (F^-) and magnesium ion (mg^{2+}) values of all the twenty five (25) water, sampled are within the limit of WHO standard. The WHO maximum permitted level are stated respectively as 500mg/l, 1000 µs/cm, 75mg/l, 1.5 and 30mg/l.

The predicted distribution map for total dissolved solids level of the watersources was shown in figure 5. The result indicated that the values for total dissolved solid for Reke-oja hand pump borehole, Kanmonnu hand pump borehole, Gbosun well 1, 2 and 4 were higher while the lower values were recorded in Alenibare hand pump borehole, Bolohunduro and Kere-aje hand pump borehole.

Table 5: Physicochemical Parameters of Various Water Sources in Various Community Schools

S/N	Location	Source	pH	Turbidity NTU	TDS Mg/L	ECµs/cm	Ca^{2+}	F^-	Mg^{2+}
WHO Standard (6.5 – 8.5)				**(< 5.0 NTU)**	**(500mgL)**		**(1000 µs/cm)**		**(75 mg/L)**
							(1.5mg/L)	**(30mg/L)**	
1.	Alenibare	Hand pumped borehole	6.5 ± 0.10	2.2 ± 0.12	51 ± 0.16	130 ± 0.10	7.5 ± 0.26	0.32 ± 0.10	3.7 ± 0.20
2.	Alenibare	Well 1	6.0 ± 0.10	2.7 ± 0.22	55 ± 0.17	133 ± 0.17	7.9 ± 0.10	0.34 ± 0.17	3.9 ± 0.20
3.	Alenibare	Well 2	6.1 ± 0.20	2.5 ± 0.10	53 ± 0.17	139 ± 0.26	8.1 ± 0.00	0.36 ± 0.00	4.2 ± 0.10
4.	Bolohunduro	Hand Pumped Borehole	6.0 ± 0.10	3.0 ± 0.10	58 ± 0.00	142 ± 0.20	8.5 ± 0.20	0.38 ± 0.10	4.2 ± 0.10
5.	Bolohunduro	Well	6.2 ± 0.20	2.9 ± 0.17	63 ± 0.23	145 ± 0.00	8.9 ± 0.20	4.0 ± 0.26	5.0 ± 0.17
6.	Gbosun	Motorized borehole	6.9 ± 0.20	2.0 ± 0.00	53 ± 0.00	132 ± 0.20	7.8 ± 0.00	0.32 ± 0.20	4.7 ± 0.10
7.	Ilota	Well 2	6.5 ± 0.50	3.1 ± 0.2	65 ± 0.17	151 ± 0.26	10.0 ± 0.17	0.41 ± 0.20	6.4 ± 0.26
8.	Kanmonu	Hand pumped borehole	6.2 ± 0.20	2.8 ± 0.02	72 ± 0.10	149 ± 0.10	9.2 ± 0.00	0.40 ± 0.10	6.1 ± 0.00

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9.	Kanmonu	Well	6.7	±	0.40	2.41	±	0.10	56	±	0.26	139	±	0.10	8.5	±	0.20	0.38	±	0.10	5.8	±	0.10
10.	Kere-aje	Well 1	6.1	±	0.45	2.7	±	0.20	75	±	0.17	148	±	0.20	9.2	±	0.10	0.39	±	0.00	6.3	±	0.10
11.	Kere-aje	Well 2	7.1	±	0.00	2.1	±	0.17	52	±	0.23	132	±	0.00	8.1	±	0.00	0.33	±	0.10	5.9	±	0.20
12.	Kere-aje	Motorized borehole	6.9	±	0.30	2.0	±	0.26	59	±	0.26	138	±	0.26	9.2	±	0.17	0.38	±	0.20	6.0	±	0.20
13.	Reke-oja	Hand pumped borehole	6.2	±	0.40	3.2	±	0.17	78	±	0.00	157	±	0.17	10.3	±	0.26	4.0	±	0.20	6.7	±	0.00
14.	Ilota	Well 1	6.5	±	0.00	2.5	±	0.10	81	±	0.26	161	±	0.17	11.1	±	0.23	0.41	±	0.10	7.2	±	0.10
15.	Ilota	Pond	5.9	±	0.10	3.9	±	0.26	65	±	0.44	171	±	0.10	11.9	±	0.20	0.42	±	0.00	7.5	±	0.10
16.	Igbonna Garage	Motorized borehole	6.1	±	0.32	2.1	±	0.00	67	±	0.00	169	±	0.10	11.6	±	0.23	0.41	±	0.17	7.3	±	0.20
17.	Igbonna Garage	Hand pumped borehole	6.0	±	0.10	2.4	±	0.10	69	±	0.10	167	±	0.20	11.2	±	0.17	0.40	±	0.10	7.1	±	0.00
18.	Ogbondoroko	Well 1	6.3	±	0.30	2.6	±	0.20	72	±	0.26	170	±	0.26	12.0	±	0.00	0.41	±	0.00	7.8	±	0.20
19.	Ogbondoroko	Well 2	6.1	±	0.10	3.0	±	0.26	75	±	0.20	173	±	0.00	12.5	±	0.00	0.43	±	0.20	7.9	±	0.10
20.	Ogbondoroko	Well 3	6.3	±	0.00	2.4	±	0.26	68	±	0.17	171	±	0.10	11.9	±	0.20	0.39	±	0.20	7.3	±	0.00
21.	Ogbondoroko	Well 4	6.6	±	0.30	2.2	±	0.17	71	±	0.00	163	±	0.20	11.7	±	0.10	0.38	±	0.10	7.2	±	0.00
22.	Ogbondoroko	Well 5	6.2	±	0.36	2.7	±	0.17	65	±	0.20	156	±	0.20	10.8	±	0.17	0.34	±	0.26	6.9	±	0.70
23.	Gbosun	Well	6.1	±	0.10	2.3	±	0.2	59	±	0.10	161	±	0.17	11.6	±	0.26	0.39	±	0.10	7.3	±	0.20
24.	Temidire	Well 1	7.1	±	0.50	2.2	±	0.26	58	±	0.26	135	±	0.00	8.1	±	0.00	0.33	±	0.20	5.5	±	0.00
25.	Temidire	Well 2	7.0	±	0.20	2.3	±	0.10	62	±	0.00	139	±	0.10	9.0	±	0.26	0.37	±	0.00	6.1	±	0.10

TDS: Total dissolved solids, Ca^{2+}: Calcium ion, F^- : Fluoride ion, EC: Electric conductivity, Mg^{2+}: Magnessium ion

IV. DISCUSSION

Ground water is a major source of drinking water and its pollution by pathogens and elevated concentration of dissolved solids are of concern due to its use for drinking and other domestic purposes including food processing (Onyango et al., 2018).

Data presented in table 1 shows that the pond water sample had the highest staphylococcal

growth count followed by the well water, hand pump borehole while the motorized borehole water sample had the lowest count likewise for microbial had for Pseudomonas and Bacillus. This is reflecting the high organic matters present in the pond followed by the wells which serve as source of nutrients to the microorganisms. This results corroborate with the findings from the study undertaken by Hamaida and Goja.

The pH value of water is an important physicochemical parameter which can be used to classify water as acidic or alkaline. The minimum and maximum acceptable pH level of any water source is 6.5 and 8.5 respectively as revealed byOko, Aremu, Odoh, Yebpella and Shenge (2014).

Odonkor and Addo (2018) reported that multidrug resistant E.coli wree isolated from well water that were resistant to four different antibiotics namely tetracycline, gentamicin, penicillin and erythromycin which corroborate with the findings of this work where two E.coli strains isolated from the well water at Temidere village were observed to be multidrug resistant.

V. CONCLUSION

Multidrug resistant Escherichia coli strains were isolated from the drinking water sources available in the study community schools which can cause diseases such as diarrhea. Hence, good quality water must be adequately provided at all times for well being of every individual most especially in our schools in rural communities.

Recommendations

- Urgent intervention in terms of adequate provisions of portable water in the community schools is highly necessary.
- The distance of well to the septic tanks should not be less than 10 metres as recommended by WHO.
- Dumping site should be far away from the source of drinking water.
- Further research should be undertaken on the strains of other bacteria isolated that might be multiple drug resistant.

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